TREK

IONizer

USER GUIDE

October 2020

TABLE OF CONTENTS

FIGURES

1 Welcome

The Telescience Resource Kit (TReK) is a suite of software applications and libraries that can be used to monitor and control assets in space or on the ground.

The TReK IONizer application provides the capability to start, stop, and monitor Interplanetary Overlay Network (ION) software.

1.1 Getting Started

Start with the Introduction which provides an application overview. Next, try the Quick Start Guides for "How Tos" for common functions. For help with details, reference the Details section. See the FAQ and Troubleshooting section for helpful hints and solutions to the common "gotchas".

2 Technical Support

If you are having trouble installing the TReK software or using any of the TReK software, please contact us for technical assistance:

TReK Help Desk E-Mail, Phone & Fax:

E-Mail: trek.help@nasa.gov
Telephone: 256-544-3521 (8:00 a.m. - 4:00 p.m. Central Time)
Fax: 256-544-9353

If you call the TReK Help Desk and you get a recording please leave a message and someone will return your call. E-mail is the preferred contact method for help. The e-mail message is automatically forwarded to the TReK developers and helps cut the response time. The HOSC Help Desk (256-544-5066) can provide assistance as needed and is available 24x7.

3 Introduction

The TReK IONizer application provides the capability to start, stop and monitor a single instance of the Interplanetary Overlay Network (ION) software.

If you are not familiar with Delay Tolerant Networking or the Interplanetary Overlay Network software, please see the TReK Delay Tolerant Networking Tutorial for an introduction to these topics.

4   Overview of the User Interface

4.1   Main Window

The main window (Monitor tab) is shown in Figure 1. The Monitor tab displays messages written to the ION log and messages about ION processes.
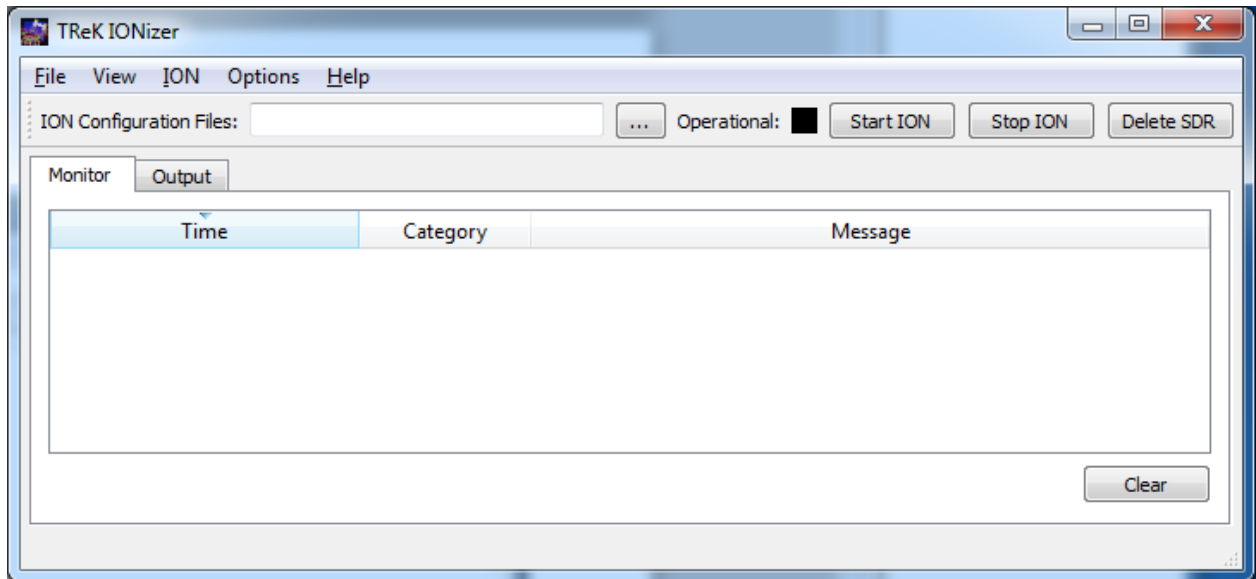
Figure 1 Main Window (Monitor Tab)

The main window (Output tab) is shown in Figure 2. The Output tab displays messages that ION writes to standard out (stdout). This includes ION watch characters.
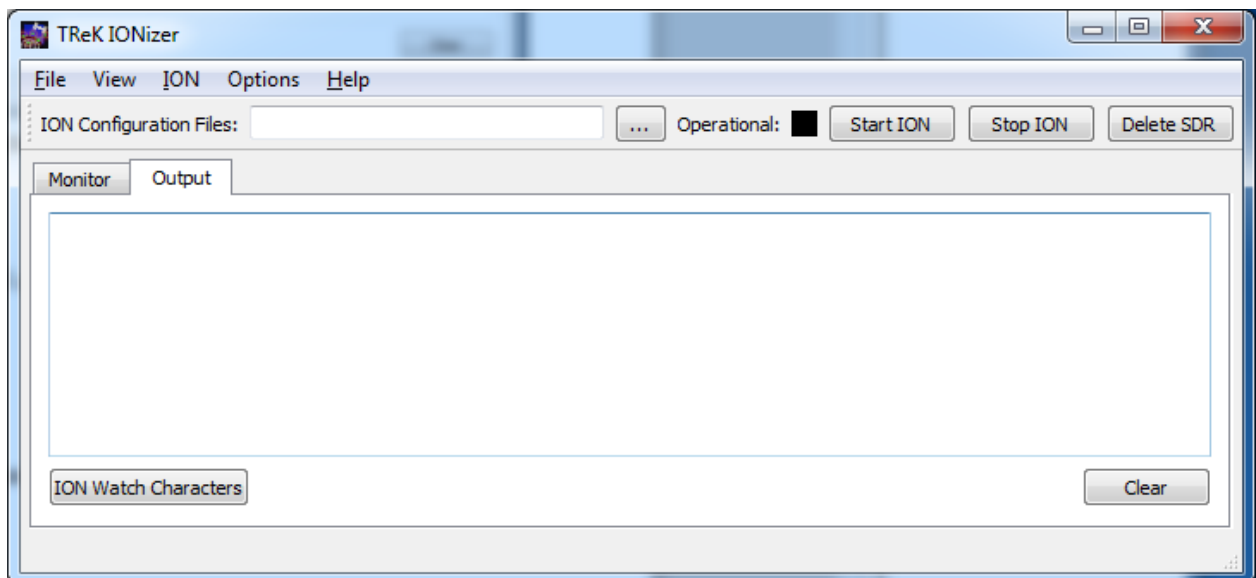
Figure 2 Main Window (Output Tab)

Figure 3 shows the IONizer console window. This window will only appear on Windows. It will be displayed when you start the IONizer application. You can safely iconify the console window to keep it out of your way. Please be sure not to close this window, or it will shut down the IONizer application. You will not see this window if you are running on Linux.
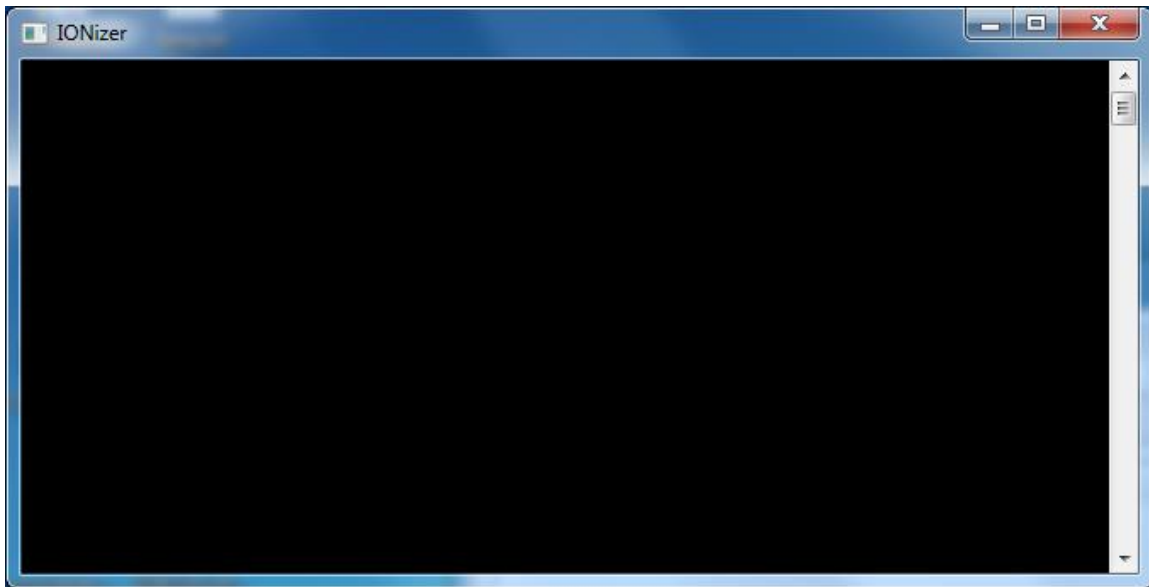
Figure 3 IONizer Console Window (Windows Only)

One of the ION configuration parameters provides the capability to run the Bundle Protocol (BP) Echo Service. If ION is configured to run the BP Echo Service, the console window shown in Figure 4 will be displayed when you start ION on Windows. You will not see this window on Linux, even if ION is configured to run the BP Echo Service. As noted in the window title, do not exit this window or it will shut down the BP Echo Service.
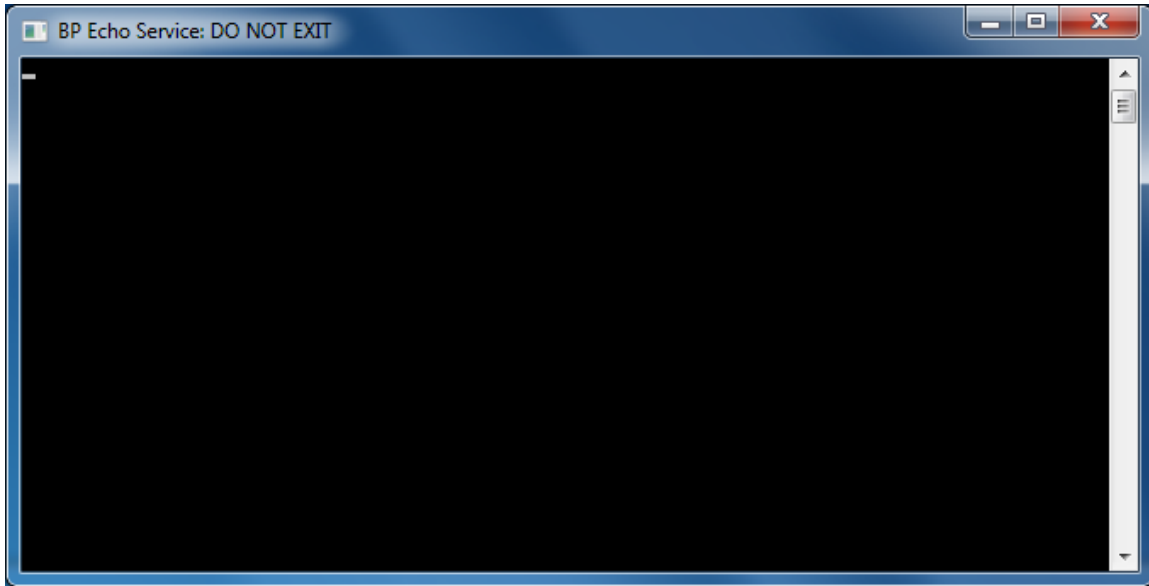
Figure 4 IONizer BP Echo Service Console Window (Windows Only)

When you stop ION on Windows, the BP Echo Service console window will close. When you exit the IONizer application on Windows, the IONizer main window and IONizer console window will both close.

Toolbars
The toolbar provides the capability to specify ION configuration files, start ION, stop ION, and delete the ION SDR.

4.2   Menus
The application menus are: File, View, ION, Options, and Help. Each of these menus is described in more detail below.

File Menu
The File menu provides the capability to exit the application.

View Menu
The View menu provides the capability to clear the main window message area and show and hide the main window message area.

ION Menu
The ION menu provides the capability to specify ION configuration files, start ION, stop ION, and delete the ION SDR.

Options Menu
The Options menu provides access to the Messages dialog. The Messages dialog displays application messages.

Help Menu
The Help menu provides access to on-line help and application version information.

5 Quick Start Guides

This section provides "How Tos" for common functions.

5.1 How to Start ION

The following steps explain how to start ION.

1. Identify the location of the ION configuration files using the field provided in the toolbar. You can use the TReK IONconfig application to create a set of ION configuration files.
2. Use the Start ION button in the toolbar to start ION (see Note 3 below for important information for ISS users). As the ION processes start, you will see status messages in the main window.

Note: If one or more of the required ION processes fail to start this will be reflected in the status messages. If this occurs, you will need to stop ION and review the ION log to determine what has gone wrong. The ION log is located in the same directory as the ION configuration files and shown in the Monitor tab. If you need to ensure ION is completely cleaned up you can go to a command prompt window and type 'killm'. This will clean up all instances of any ION processes on the computer. Use caution when using killm.

Note 2: The ION configuration files must be located on a local drive. If you attempt to use ION configuration files located on a shared drive, this can cause the IONizer application to crash.

Note 3: When connecting to the HOSC DTN ground gateway for ISS, a dialog box with two options will appear. Each option is explained below:

- ➤ Auto reconfiguration – This is the recommended option. It will automatically reconfigure ION to match the information provided by the HOSC DTN ground gateway using a series of scripts and the ION configuration files.
- ➤ ION as configured – This option will run with the ION configuration files as is. This allows users to configure ION completely as needed, but may require periodic changes to the ION configuration files.

5.2 How to Stop ION

The following steps explain how to stop ION.

1. Use the Stop ION button in the toolbar to stop ION. As the ION processes stop, you will see status messages in the main window.

5.3   How to Delete the ION SDR

The following steps explain how to delete the ION SDR.

1. Use the Delete ION SDR button in the toolbar to delete the SDR. ION will be stopped and the SDR will be deleted.

Note: Be aware that deleting the SDR will delete all data ION was storing in preparation for transmitting as well as partially received data.

5.4   How to Clear ION Log and Process Status Messages

The following steps explain how to clear ION log and process status messages.

1. Use the Clear button located on the Monitor tab. Once the messages are cleared, there is no way to recover them.

5.5   How to Clear ION Output Messages

The following steps explain how to clear ION output messages.

1. Use the Clear button located on the Output tab. Once the output is cleared, there is no way to recover it.

6   Details
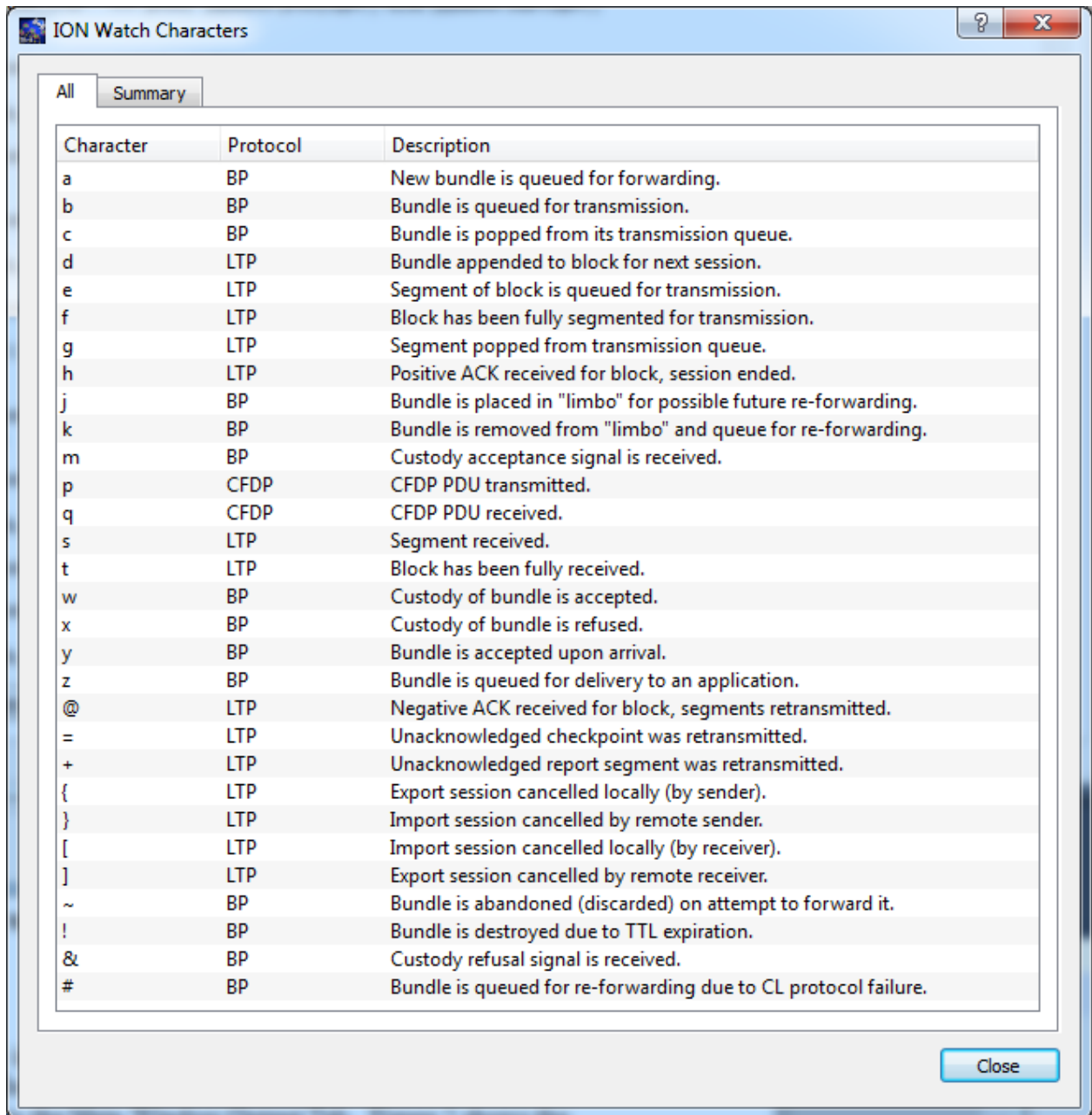
This section covers various application details.

6.1   ION Watch Characters

The ION Watch Characters dialog contains two tabs: All and Summary.

6.1.1   All Tab

The All tab is shown in Figure 5. The All tab provides a list of all the ION watch characters, the protocol associated with the watch character, and a short description.

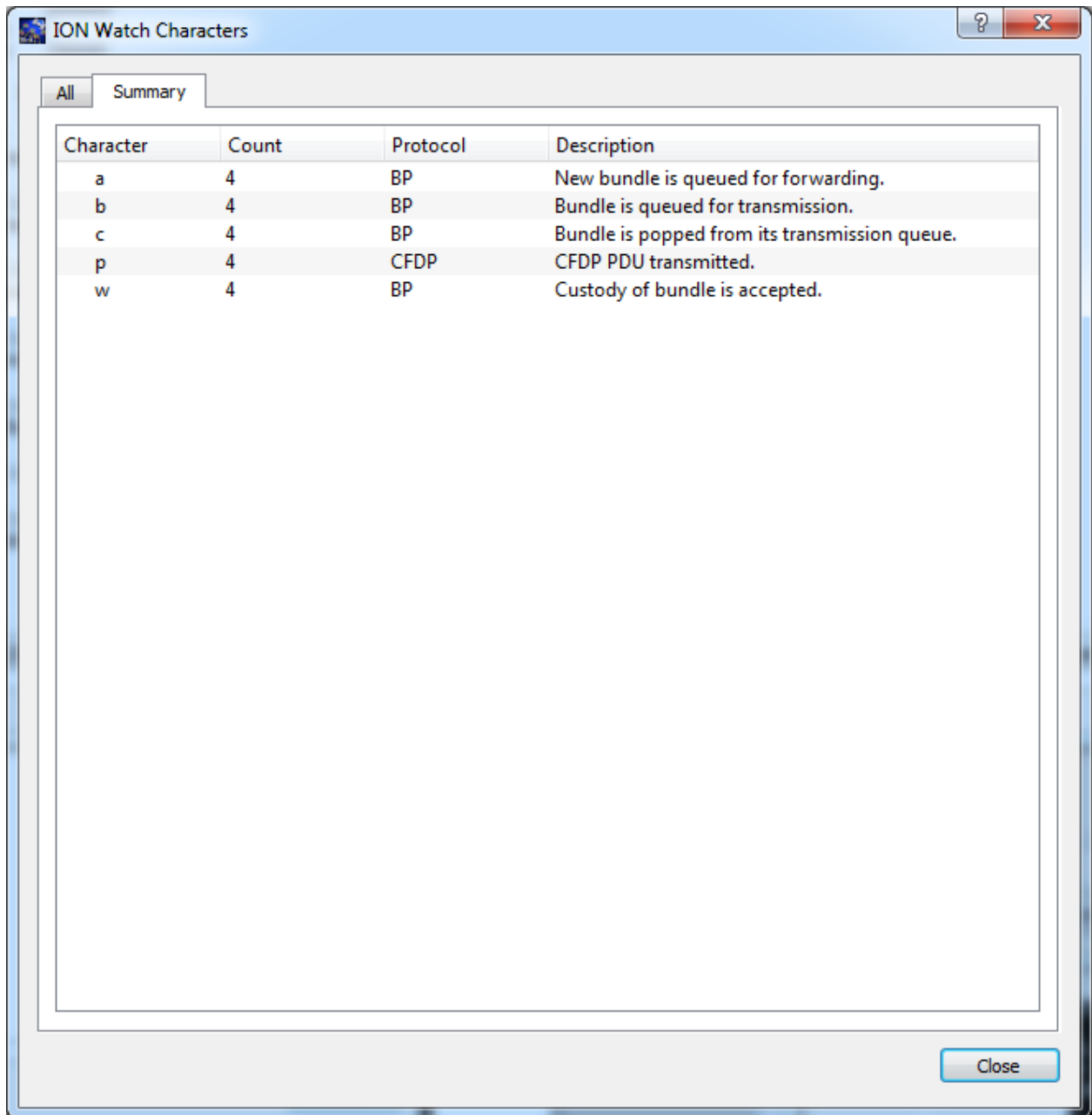| Character	Protocol	Description
a	BP	New bundle is queued for forwarding.
b	BP	Bundle is queued for transmission.
c	BP	Bundle is popped from its transmission queue.
d	LTP	Bundle appended to block for next session.
e	LTP	Segment of block is queued for transmission.
f	LTP	Block has been fully segmented for transmission.
g	LTP	Segment popped from transmission queue.
h	LTP	Positive ACK received for block, session ended.
j	BP	Bundle is placed in "limbo" for possible future re-forwarding.
k	BP	Bundle is removed from "limbo" and queue for re-forwarding.
m	BP	Custody acceptance signal is received.
p	CFDP	CFDP PDU transmitted.
q	CFDP	CFDP PDU received.
s	LTP	Segment received.
t	LTP	Block has been fully received.
w	BP	Custody of bundle is accepted.
x	BP	Custody of bundle is refused.
y	BP	Bundle is accepted upon arrival.
z	BP	Bundle is queued for delivery to an application.
@	LTP	Negative ACK received for block, segments retransmitted.
=	LTP	Unacknowledged checkpoint was retransmitted.
+	LTP	Unacknowledged report segment was retransmitted.
{	LTP	Export session cancelled locally (by sender).
}	LTP	Import session cancelled by remote sender.
[	LTP	Import session cancelled locally (by receiver).
]	LTP	Export session cancelled by remote receiver.
~	BP	Bundle is abandoned (discarded) on attempt to forward it.
!	BP	Bundle is destroyed due to TTL expiration.
&	BP	Custody refusal signal is received.
#	BP	Bundle is queued for re-forwarding due to CL protocol failure.

Figure 5 ION Watch Characters Dialog (All Tab)

6.1.2   Summary Tab

The Summary Tab shows summary information about the ION watch characters selected in the Main Window Output tab. The Summary Tab will be empty if you have not selected any ION watch characters in the Main Window Output Tab. Figure 6 shows the Main Window Output tab with some ION watch characters selected.
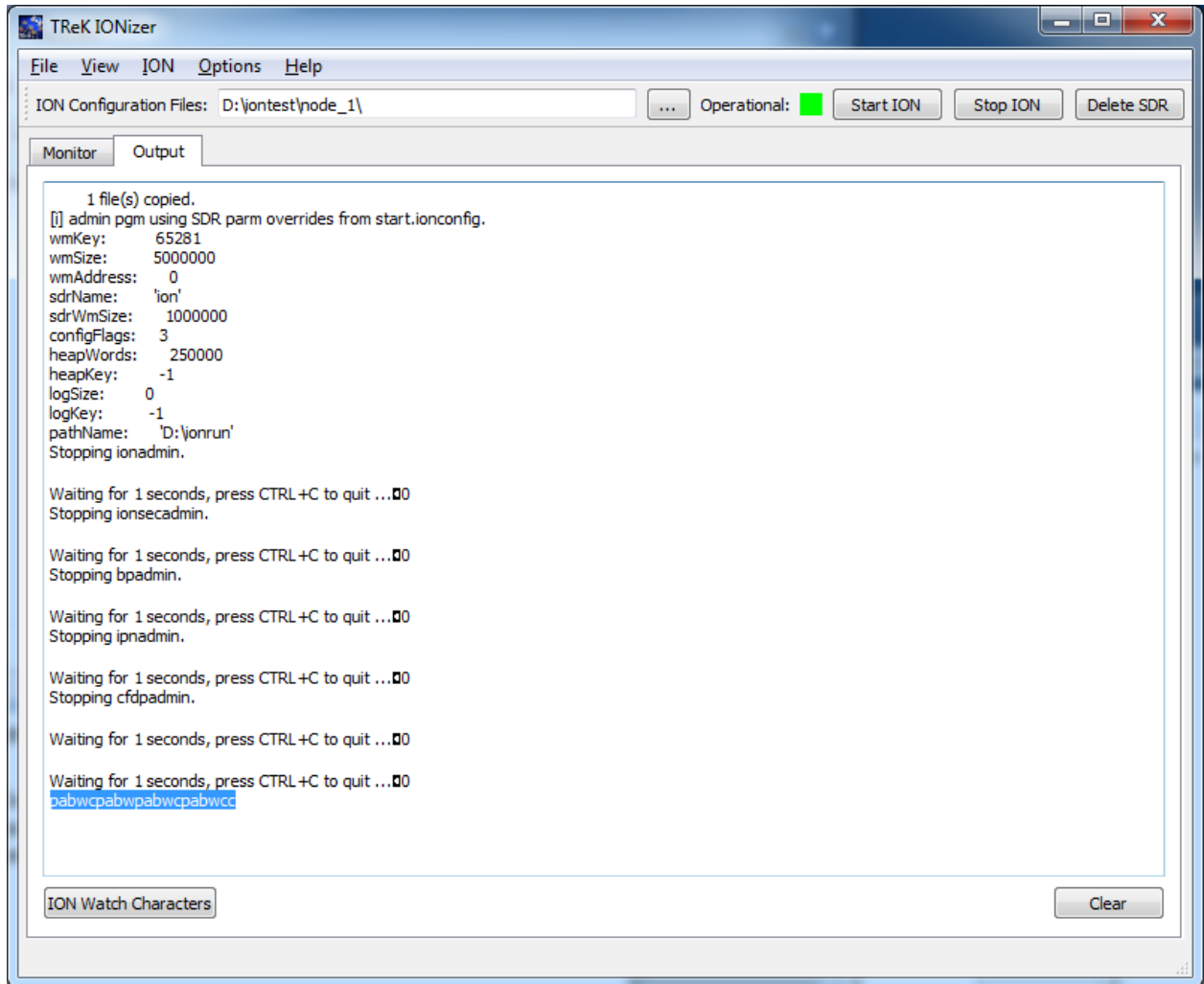
Figure 6 Selected ION Watch Characters

Figure 7 shows what the Summary tab will look like when it is populated after you select ION watch characters in the Main Window Output Tab and push the ION Watch Characters button. This information can be helpful when debugging.

Character	Count	Protocol	Description
a	4	BP	New bundle is queued for forwarding.
b	4	BP	Bundle is queued for transmission.
c	4	BP	Bundle is popped from its transmission queue.
p	4	CFDP	CFDP PDU transmitted.
w	4	BP	Custody of bundle is accepted.

Figure 7 ION Watch Characters Dialog (Summary Tab)

6.2   Manage E-Mail and Text Settings Dialog

The Manage E-Mail and Text Settings Dialog is shown in Figure 8. This dialog provides the capability to manage global e-mail and text settings, application alert settings, e-mail and text dropboxes, and the capability to send an e-mail or text.
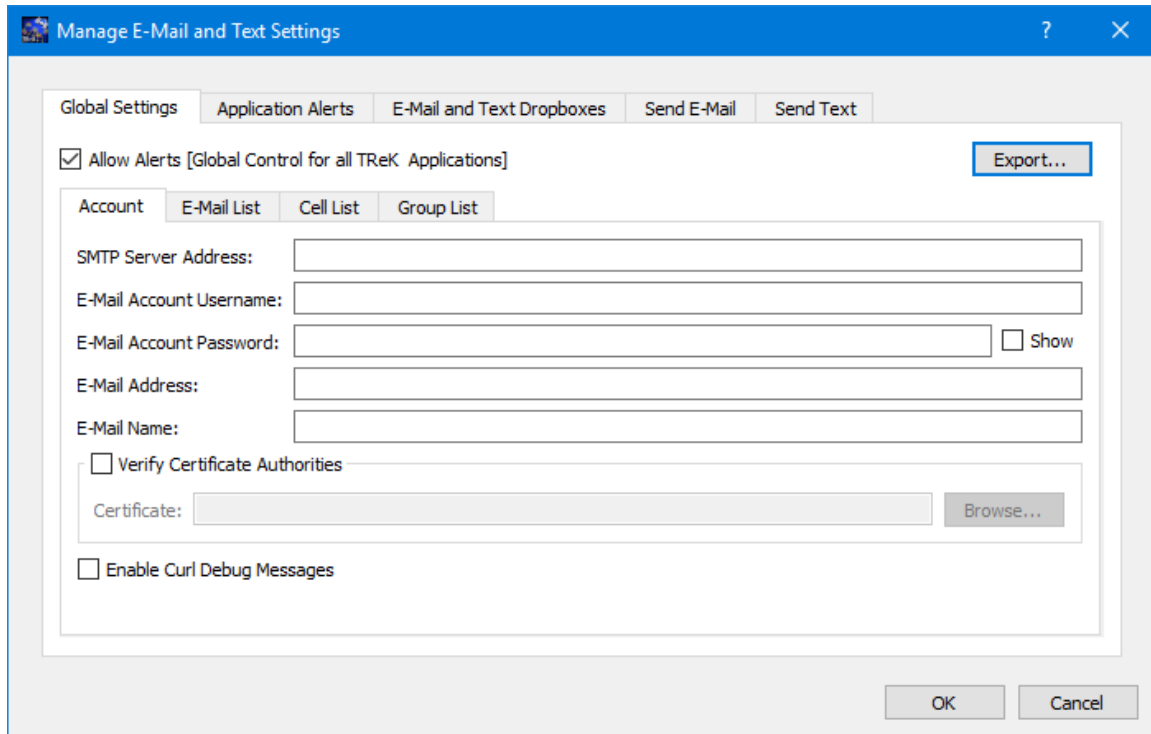
Figure 8 Manage E-Mail and Text Settings Dialog (Global Settings Account Tab)

The TReK software's e-mail and text capability is dependent on libcurl, an open source client-side URL transfer library developed by the cURL project. The libcurl library provides C API functions that configure the library to programmatically establish a secure connection with an email server using a Transport Layer Security (TLS) version 1.3 socket prior to logging into an email account using an email account name and password.

The TReK email and text capability has been successfully tested with the Google gmail server. It is recommended that users create a new gmail account and use it to send emails and texts to designated recipients. The TReK software does not support retrieving emails from the user's gmail account. When creating the gmail account to send emails and texts, the user must change the security settings under the "Manage your Google Account" button under the user's "Google Account" widget (found in the top right hand corner of the user's gmail account web page). After choosing "Security" from a list of items found on the user's "Google Account" web page, the user must scroll down to the section on the web page titled "Less secure app access" and turn on this access setting. This setting enables the TReK software's email library access to the user's gmail account using a TLS socket that encrypts all traffic between the the TReK email library and the user's gmail account including the user's account name and password. Google will automatically turn this setting off if it's not being used. After turning on "Less secure app access", users will receive a warning message saying their account is vulnerable to malicious activity because of a less secure sign-in technology and recommend turning off this type of access. TReK recommends only using the account to send emails and texts using the TReK software. TReK does not recommend using the account to receive emails.

The maximum size of a text message is approximately 900 characters. However, if you send more than 900 characters your message may be broken up during transmission and then concatenated on the recipient's phone. The maximum length of a TReK email message is 65,000 characters or bytes. The maximum length of an email with a file attachment is generally considered to be 10MB (email message size plus file attachment size). Note, file attachments may become much larger than their original file sizes. This is due to the encoding employed by email servers when sending non text-based information.

Global Settings
Global Settings are e-mail and text settings used in all TReK applications. They can be changed in any TReK application with a Manage E-Mail and Text Settings dialog. When you change a setting on the Global Settings tab, it will be changed for all TReK applications. Each Tab is described below.

Allow Alerts
The Allow Alerts Checkbox is a global setting to turn on and off all alerts in all TReK applications. If you turn this checkbox off, no alerts will be generated in any applications.

Export
The Export button provides access to the Export dialog shown Figure 9. This dialog provides the capability to save the settings on the Global Settings tab in a TReK email configuration file that can be used with the TReK E-Mail and Text API. You also have the option to include the dropboxes defined on the E-Mail and Text Dropboxes tab.
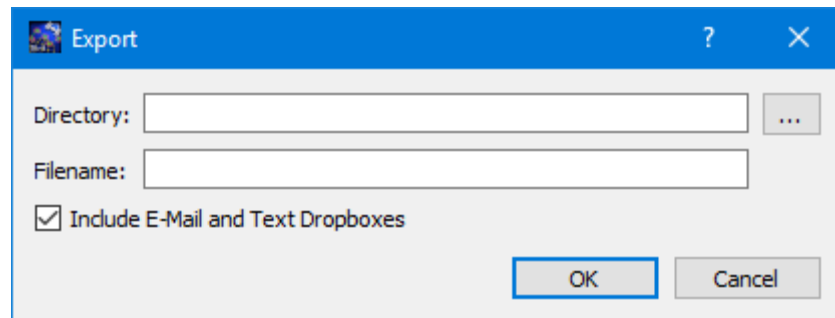
Figure 9 Manage E-Mail and Text Settings (Export Dialog)

Account
In order to use the Alerts capability, you must have a Gmail account. The Gmail account must be configured to allow third party access. The Account tab is used to enter your Gmail account information. The account password will be hidden by default and will be encrypted when it is stored. It will only be decrypted when it is used to log into the account to execute a requested function. An example of account information is shown below.

11

smtp_server_address: smtp.gmail.com
email_account_username: jane.doe@gmail.com
email_account_password: secretPassword [Hidden unless show checkbox is checked]
email_address: jane.doe@gmail.com
email_name: Jane Doe

The Verify Certificate Authorities checkbox is used to turn on the certificate authority check. If you turn on the certificate authority check, you must provide the complete path to a Certificate file.

The Enable Curl Debug Messages checkbox is used to turn on additional debug messages generated by the curl software library.

E-Mail List

The E-Mail List tab is used to enter e-mail addresses that will be used to populate the e-mail address list that is available when configuring alert functions or sending an e-mail. The E-Mail List tab is shown in Figure 10. The Add button is used to add a row to enter e-mail address information. The Delete button is used to delete a row.
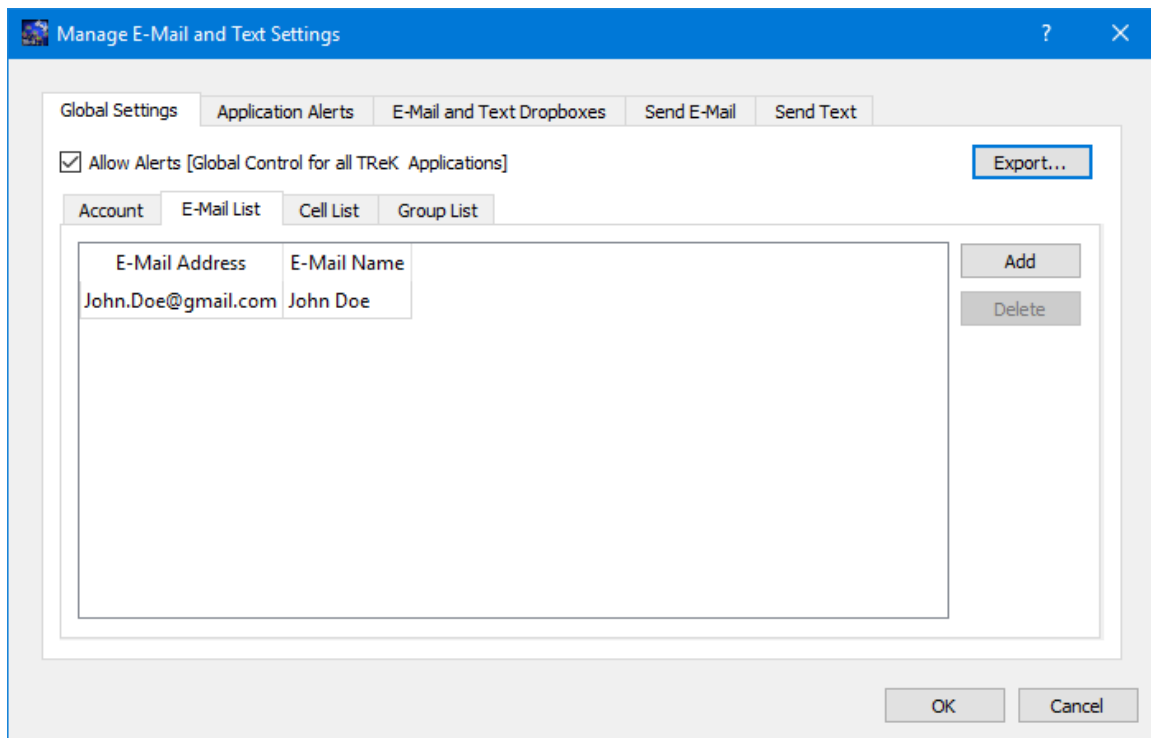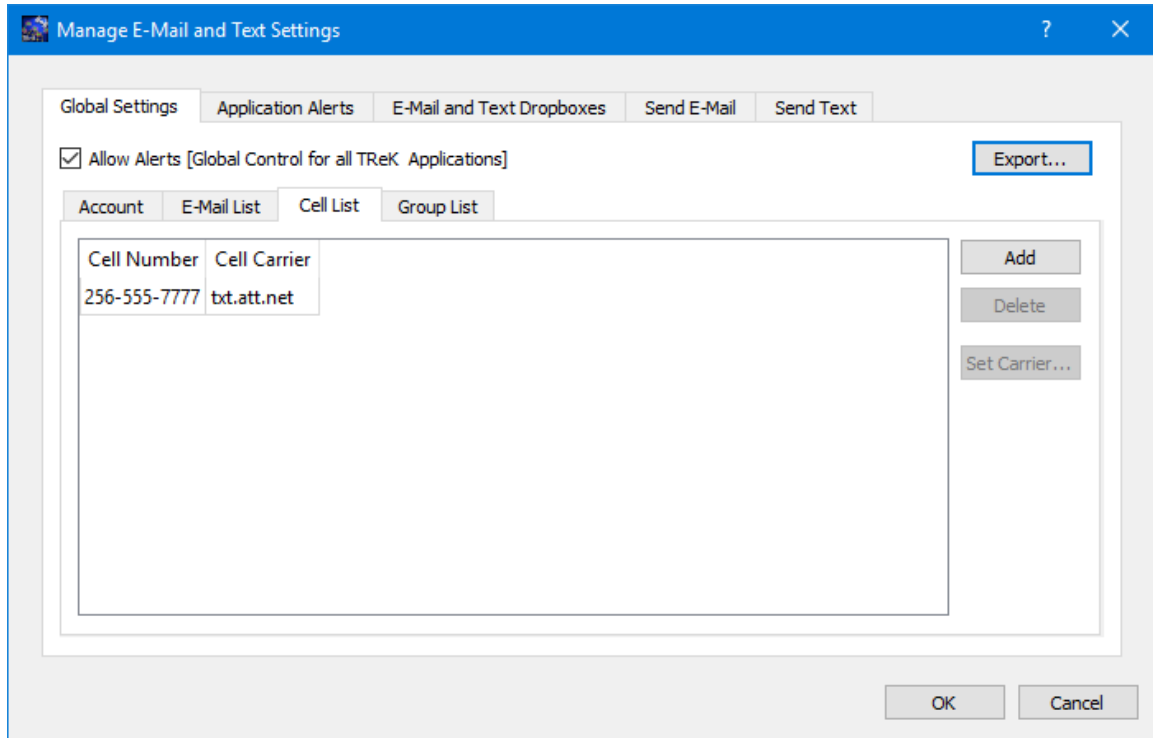

Figure 10 Manage E-Mail and Text Settings Dialog (Global Settings E-Mail List Tab)

Cell List

The Cell List tab is used to enter mobile cell phone numbers that will be used to populate the Cell list that is available when configuring alert functions or sending a text. The Cell

List tab is shown in Figure 11. The Add button is used to add a row to enter cell number information. The Delete button is used to delete a row. Cell numbers can be entered with or without dashes. The Set Carrier button is available when a Cell Carrier cell is selected. It is shown in Figure 12 and can be used to select a carrier address. If the carrier address you need is not in the list, you can enter it directly into the cell.

Figure 11 Manage E-Mail and Text Settings Dialog (Global Settings Cell List Tab)
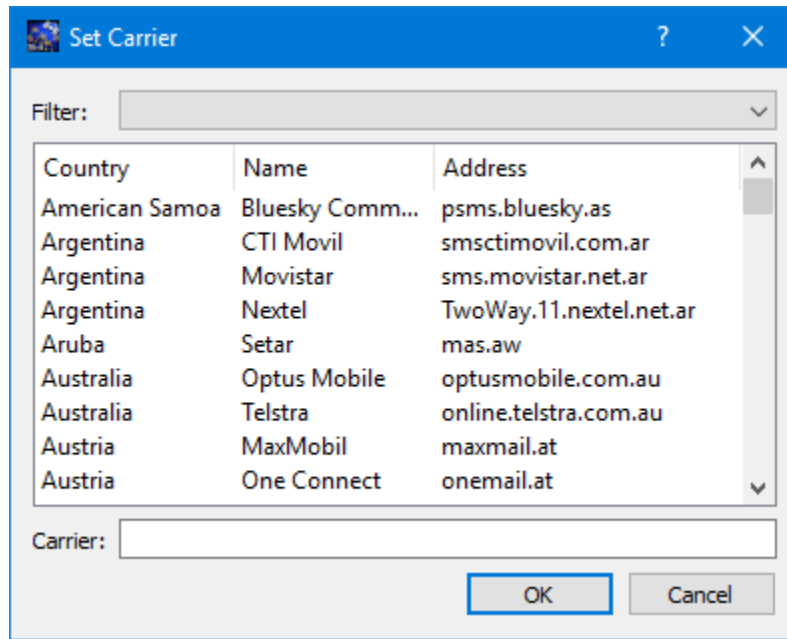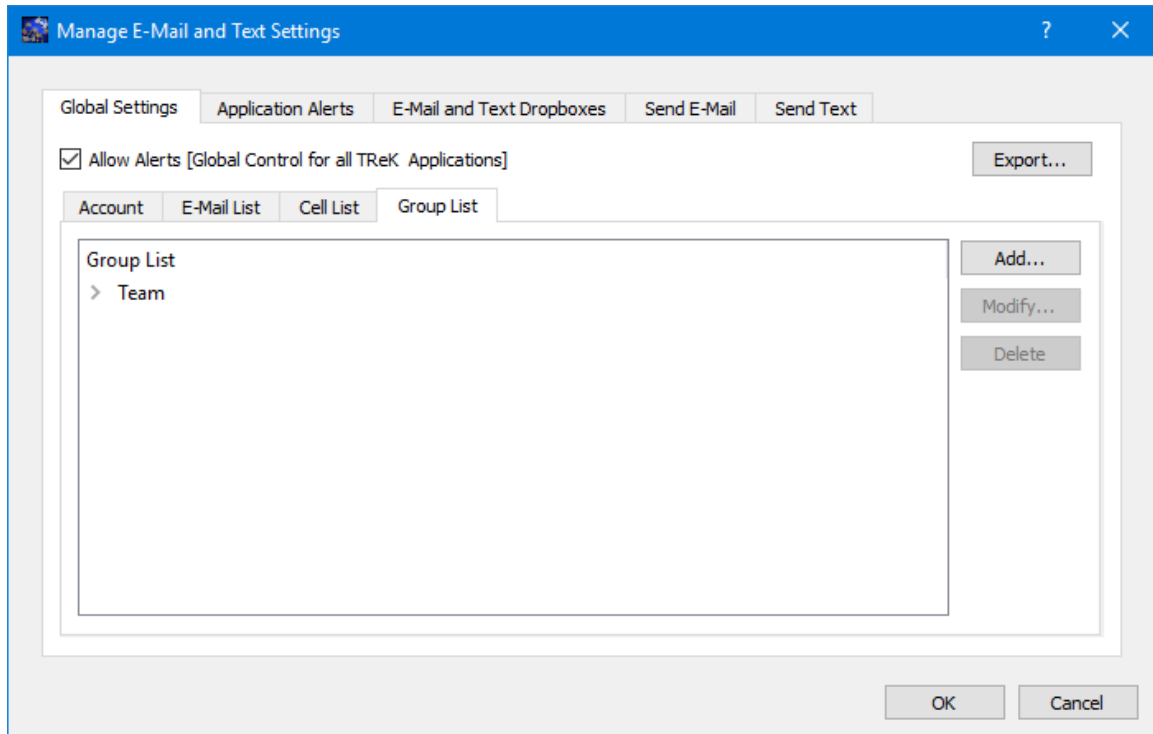
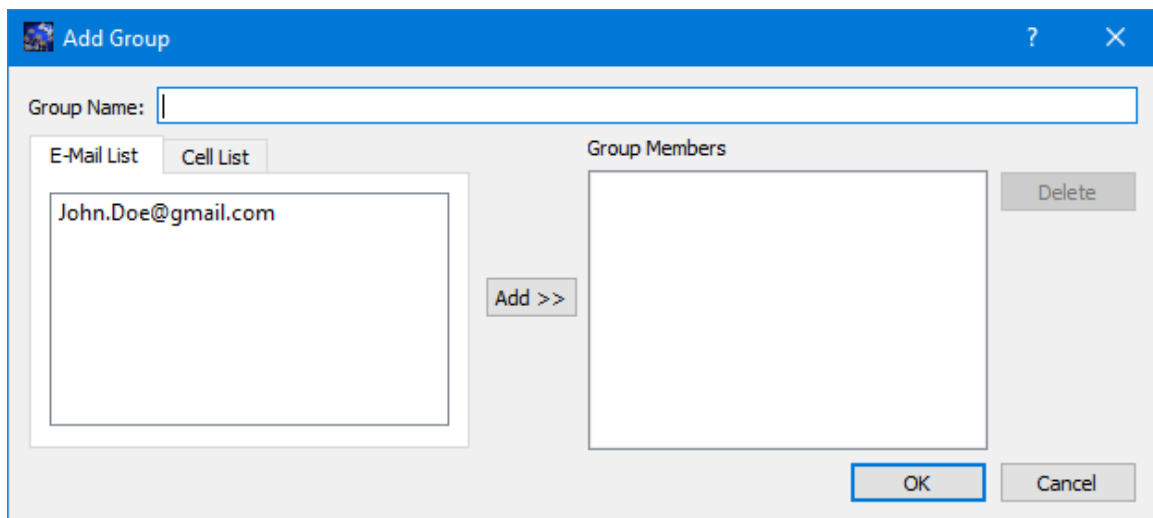**Figure 12 Manage E-Mail and Text Settings (Set Carrier Dialog)**

Group List

When configuring an application alert or sending an e-mail or text, you will have the option to identify an e-mail address, a cell phone number, or a group as a recipient. The Group List is shown in Figure 13. You can define zero or more groups. A group can contain e-mail addresses and cell numbers. If you have a group with both e-mail addresses and cell numbers and you send an e-mail to that group, the e-mail generated will only be sent to the e-mail addresses in the group. You can add, modify, and delete a group using the buttons on the right.

Figure 13 Manage E-Mail and Text Settings Dialog (Global Settings Group List Tab)

The Add button will display the Add Group dialog shown in Figure 14. At the top you can enter a name for the group. On the left you will see all the e-mail addresses and cell numbers you entered on the Global Settings main E-Mail List and Cell List tabs. You can add zero or more e-mail addresses and zero or more cell numbers to a group. To add an e-mail or cell to the group, select the e-mail or cell number on the left and push the Add button to add it to the group. You can use the Delete button to delete a recipient from the group.

Figure 14 Manage E-Mail and Text Settings (Add Group Dialog)

Application Alerts

The Application Alerts tab is shown in Figure 15. It is used to configure application specific alerts.
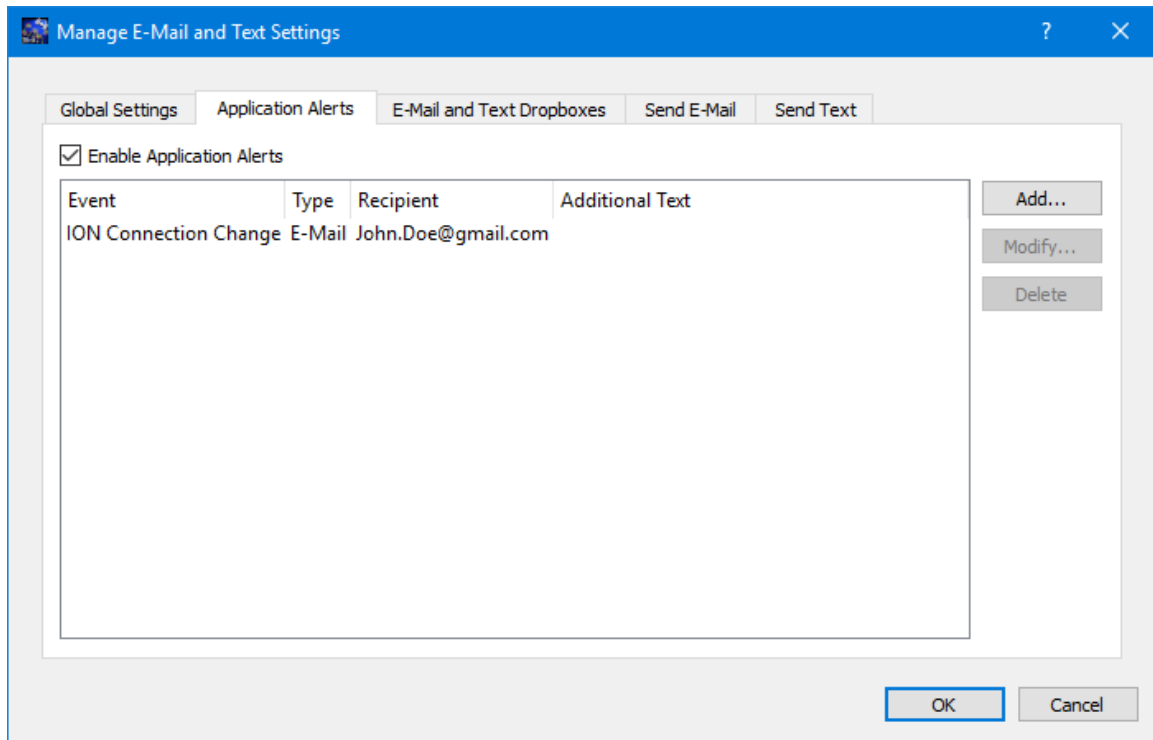
Figure 15 Manage E-Mail and Text Settings Dialog (Application Alerts Tab)

Enable Application Alerts

The Enable Application Alerts Checkbox is used to turn all alerts on or off in the current application. If you uncheck Enable Application Alerts, no alerts will be generated in the Command application.

Event List

The Event area provides the capability to identify one or more alerts to send when a specific application event occurs. You can add, modify, and delete alerts using the buttons on the right. The Add button will display the Add Alert dialog shown in Figure 16.
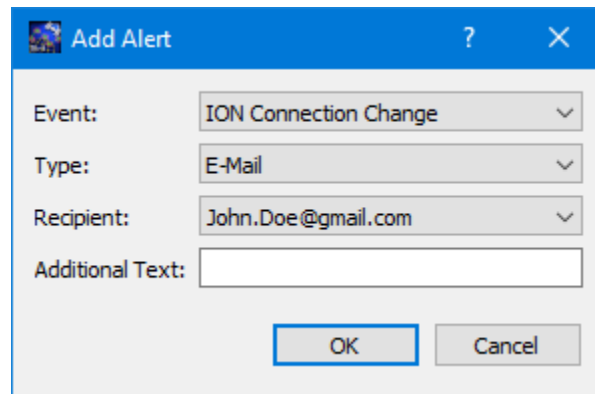
Figure 16 Manage E-Mail and Text Settings (Add Alert Dialog)

Event
The Event is what triggers the alert. There may be one or more events in an application that can trigger an alert. The IONizer application can generate an alert for the following types of events:

ION Connection Change
This event is triggered if the connection to ION changes (connects or disconnects).

Type
The type of alert to send. Options are E-Mail, E-Mail and Text, or Text.

Recipient
The recipient identifies who should be notified when the event is triggered. The Recipient list will be populated with applicable recipients based on Type. If you select E-Mail in the Type menu, the Recipient list will be populated with e-mails from the E-Mail List tab and groups that contain at least one e-mail address from the Group List tab. If you select E-Mail and Text in the Type menu, the Recipient list will be populated with groups from the Group List tab that contain at least one e-mail address and one cell phone number. If you select Text in the Type menu, the Recipient list will be populated with cell phone numbers from the Cell List tab and groups that contain at least one cell phone number from the Group List tab.

Additional Text
The alert will contain the name of the event that occurred and any text that is provided in the Additional Text field. Additional Text is optional.

E-Mail and Text Dropboxes
The E-Mail and Text Dropboxes tab is shown in Figure 17. This tab can be used to define E-Mail and Text Dropboxes. It is important to remember that each E-Mail and Text Dropbox will correspond to a directory on the file system and must be unique. Using a directory for more than one dropbox will result in unexpected behavior. When

you define a dropbox using the Manage E-Mail and Text Settings dialog, the dropbox information is automatically saved with that specific application's settings.
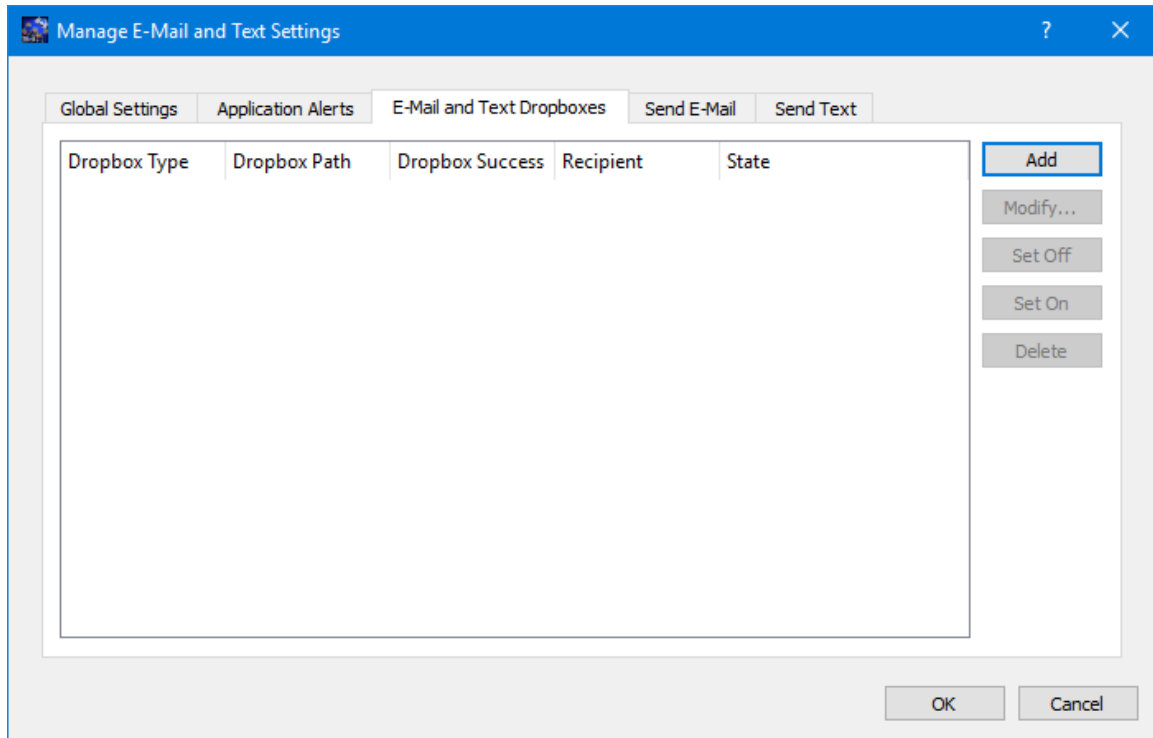
Figure 17 Manage E-Mail and Text Settings Dialog (E-Mail and Text Dropboxes Tab)

Dropbox List

The Dropbox List is used to define zero or more dropboxes. For each dropbox you can define the Dropbox Type, the Dropbox Path, the Dropbox Success Path, a Recipient, and a State. The buttons on the right can be used to add, modify, delete, or change the state of a dropbox. The Add Dropbox dialog is shown in Figure 18.
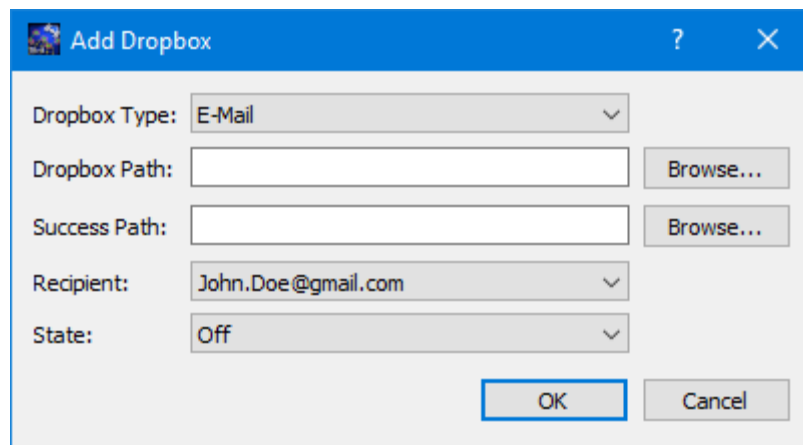
Figure 18 Manage E-Mail and Text Settings (Add Dropbox Dialog)

Dropbox Type
There are three types of dropboxes: E-Mail, E-Mail File, and Text. An E-Mail dropbox will e-mail the contents of a file placed in the dropbox. An E-Mail File dropbox will e-mail the file placed in the dropbox. A Text dropbox will text the contents of a file placed in the dropbox.

Dropbox Path
The Dropbox Path identifies the local directory to be used for the dropbox. The Browse button can be used to select a directory.

Dropbox Success Path
The Dropbox Success Path is optional. If the Dropbox Success Path is defined, the dropbox will move the original file placed in the dropbox to the success directory if and only if the corresponding e-mail or text is successfully delivered to the e-mail server. If the success path is empty, the dropbox will delete the original file placed in the dropbox if and only if the corresponding e-mail or text is successfully delivered to the e-mail server. If the dropbox fails to generate the e-mail or text, the file will be renamed with a time tagged ".droperror" extension and remain in the dropbox. The dropbox will not attempt to generate an e-mail or text for a file with a ".droperror" extension in its filename.

Recipient
The Recipient identifies the designated recipient(s) for the e-mail or text. The Recipient list will be populated with applicable recipients based on the Dropbox Type. For example, if you select E-Mail or E-Mail File in the Type menu, the Recipient list will be populated with e-mails from the E-Mail List Tab and groups with at least one e-mail address from the Group List Tab. If you select Text in the Type menu, the Recipient list will be populated with cell phone numbers from the Cell List Tab and groups with at least one cell number from the Group List Tab.

State
The state controls whether the dropbox is activated. It can be set to Off or On. If the state is set to Off, the dropbox will not be activated. If the state is set to On, the dropbox will be activated when you push the OK button. If the state is set to On when you exit the application, it will automatically be activated the next time you run the application. If you do not want the dropbox to be activated on application initialization, set the state to Off before exiting the application.

Send E-Mail
The Send E-Mail tab is shown in Figure 19. This tab can be used to send an e-mail if valid information has been entered on the Global Settings tab. Once the To, Subject, optional File (Browse can be used to browse the local disk for a file), and Message information has been entered, press the Send button to send the e-mail. This will initiate

a request to send the e-mail. Look at the main window message area for information about whether the e-mail request was successful or encountered any errors.
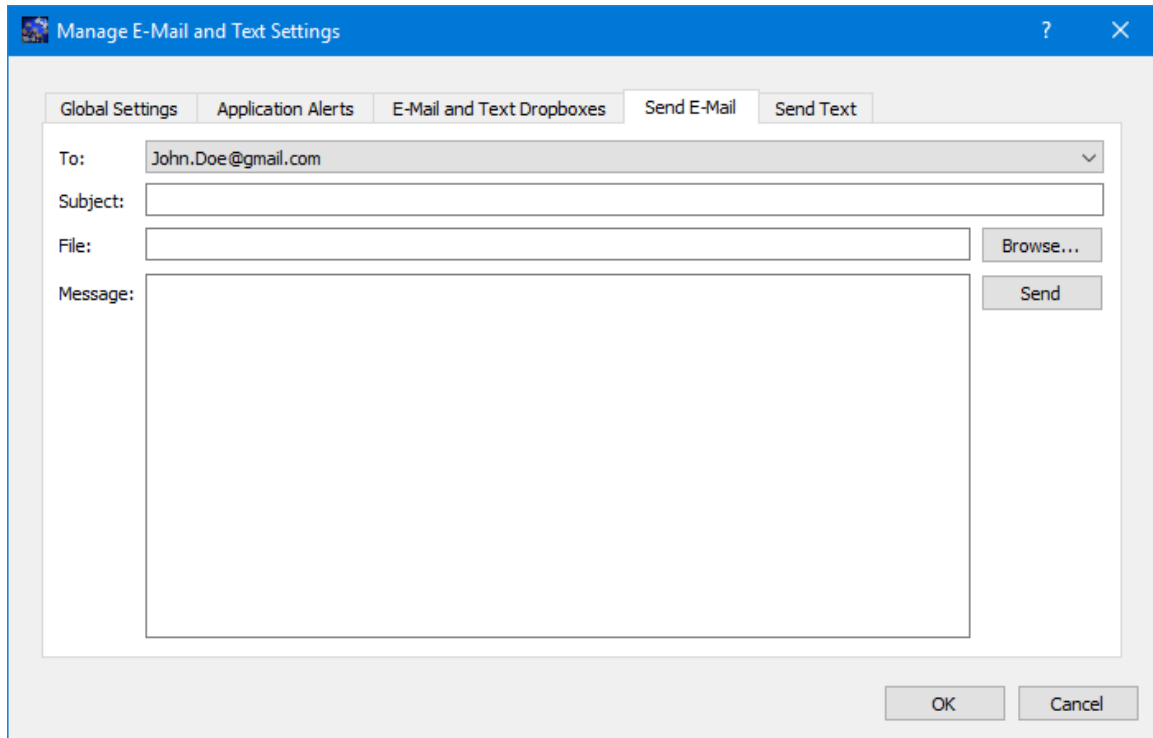
Figure 19 Manage E-Mail and Text Settings Dialog (Send E-Mail Tab)

Send Text

The Send Text tab is shown in Figure 20. This tab can be used to send a text if valid information has been entered on the Global Settings tab. Once the To and Message information has been entered, press the Send button to send the text. This will initiate a request to send the text. Look at the main window message area for information about whether the text request was successful or encountered any errors.
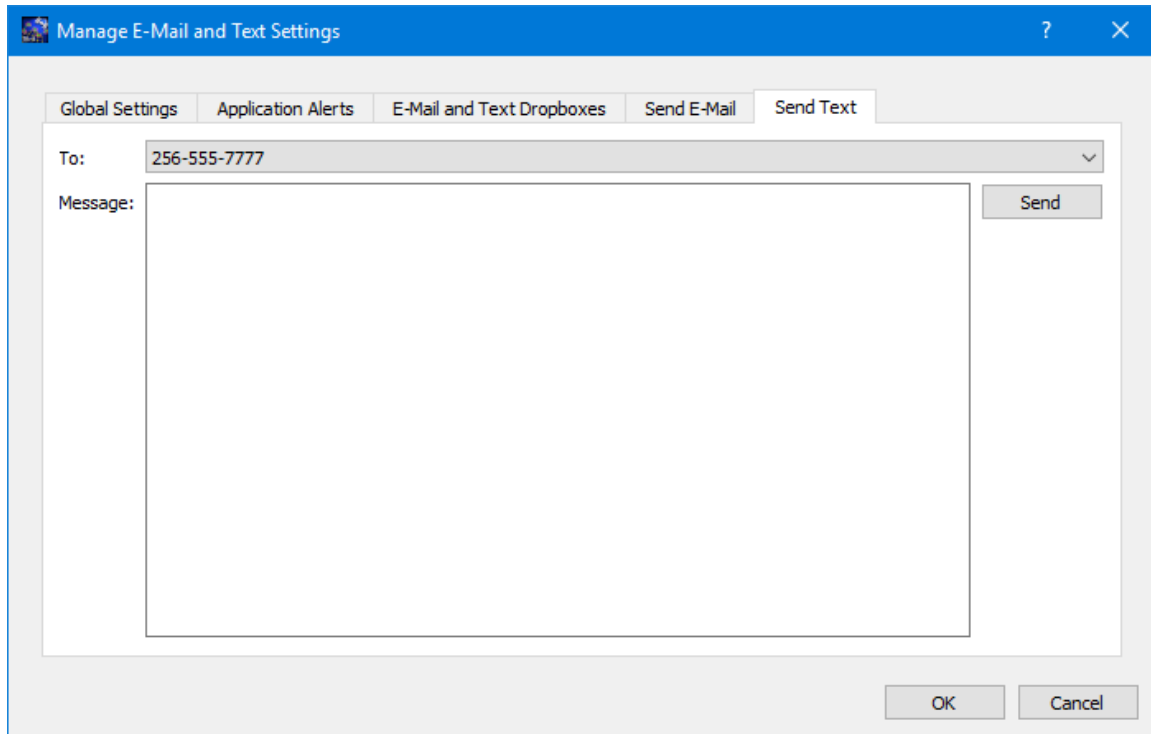
Figure 20 Manage E-Mail and Text Settings Dialog (Send Text Tab)

6.3   Application Settings

The IONizer application saves some settings as application settings each time you exit the application.   The next time you run the application, the application will initialize with the previous application settings. The following application settings are saved:

- ➤ Application Window Size
- ➤ ION Configuration Files Directory
- ➤ E-Mail and Text Settings

7   FAQ and Troubleshooting

This section addresses Frequently Asked Questions and provides tips for troubleshooting common gotchas.

7.1   What is ION?

The following text is from the Interplanetary Overlay Network (ION) documentation:

"The Interplanetary Overlay Network (ION) software distribution is an implementation of Delay-Tolerant Networking (DTN) architecture as described in Internet RFC 4838. It is

designed to enable inexpensive insertion of DTN functionality into embedded systems such as robotic spacecraft. The intent of ION deployment in space flight mission systems is to reduce cost and risk in mission communications by simplifying the construction and operation of automated digital data communication networks spanning space links, planetary surface links, and terrestrial links.

A comprehensive overview of DTN is beyond the scope of this document. Very briefly, though, DTN is a digital communication networking technology that enables data to be conveyed between two communicating entities automatically and reliably even if one or more of the network links in the end-to-end path between those entities is subject to very long signal propagation latency and/or prolonged intervals of unavailability."

7.2   What should I do if there are errors when I start ION?

Review the messages in the IONizer main window and the ION log file. The ION log file will be located in the directory with the ION configuration files. Some common problems that can occur:

a.   The local IP Address has changed. If you started ION using an existing SDR file that contained an old IP address this can cause problems. If this occurs you will need to decide whether to modify the SDR via ION provided administrative programs to update the IP address or to delete the SDR (losing any data stored in the SDR).

b.   The ION configuration files contain information that is incorrect (such as an IP address) or missing information.

Note: When using the TReK IONconfig application to create ION configuration files it is important to ensure the entire diagram (all nodes and ducts) contain valid information or at least no conflicting information. For example, if you use the same local IP address and port 4556 for all nodes in the diagram this will cause an error when you try to start ION. The nodes either need to use different IP addresses or different ports. Even though you may only be using the configuration files for one of the nodes, the ION configuration files contain many interrelated parameters that are derived from information across the entire diagram.